

Author: Kimmel, Oscar Allen

**Title: Functional mathematics for students of vocational
agriculture in Pennsylvania**

Place of Publication:

Copyright Date: 1945

Master Negative Storage Number: MNS# PStSNPaAg032.10

<107350> * *OCLC* Form:manuscript item 2 Input:BMM Edit:FMD
 008 ENT: 980223 TYP: s DT1: 1945 DT2: LAN: eng
 035 (OCoLC)38448417
 037 PSt SNP aAg032.10 \$bPreservation Office, The Pennsylvania State
 University, Pattee Library, University Park, PA 16802-1805
 090 20 Thesis 1945m \$bKimme,OA \$cst*21881015 \$cax+(Archival)
 090 20 Microfilm D344 reel 32.10 \$cmc+(service copy, print master, archival
 master)
 100 1 Kimmel, Oscar Allen.
 245 10 Functional mathematics for students of vocational agriculture in
 Pennsylvania \$ba thesis \$cby Oscar Allen Kimmel.
 260 \$c1945.
 300 [51] leaves \$c29 cm.
 502 Thesis (M.S.)--Pennsylvania State College.
 504 Bibliography: leaves 43-45.
 533 Microfilm \$bUniversity Park, Pa. : \$cPennsylvania State University
 \$d1997. \$e1 microfilm reel ; 35 mm. \$f(USAIN state and local literature
 preservation project. Pennsylvania) \$f(Pennsylvania agricultural
 literature on microfilm).
 590 Archival master stored at National Agricultural Library, Beltsville, MD
 : print master stored at remote facility.
 590 This item is temporarily out of the library during the filming process.
 If you wish to be notified when it returns, please fill out a Personal
 Reserve slip. The slips are available in the Rare Books Room, in the
 Microforms Room, and at the Circulation desk.
 650 0 Agricultural education \$zPennsylvania.
 650 0 Mathematics \$xStudy and teaching (secondary)
 830 0 USAIN state and local literature preservation project. \$pPennsylvania.
 830 0 Pennsylvania agricultural literature on microfilm.

The Pennsylvania State College
The Graduate School
Department of Agricultural Education

FUNCTIONAL MATHEMATICS
FOR STUDENTS OF VOCATIONAL AGRICULTURE
IN PENNSYLVANIA

A Thesis

by

Oscar Allen Kimmel

Submitted in partial fulfillment

of the requirements

for the degree of

Master of Science

October 1945

Approved:

Oct. 1, 1945

Henry J. Brunner
Head of the Department

ACKNOWLEDGMENTS

The writer wishes to express his sincere thanks and to acknowledge his indebtedness to all who have made this study possible and who have assisted in its preparation.

To Mr. V. A. Martin for his letter suggesting procedure in contacting area supervisors.

To the area supervisors who responded to the form letters.

To the teachers of vocational agriculture who responded to the questionnaires.

To Doctor Clarence S. Anderson for his assistance in planning the study.

To Doctor Henry S. Brunner for guidance and counsel in preparing the manuscript.

To my wife, Nora E. Kimmel, whose constant encouragement contributed very materially to the realization of this accomplishment.

TABLE OF CONTENTS

Chapter		Page
I.	INTRODUCTION	1
	The General Problem	1
	Setting and Need	3
	The Problem Delimited	3
	Scope of Study	4
	Review of Related Literature	4
	Sources of Data	7
	Procedure	10
II.	COLLECTION AND TREATMENT OF DATA	11
	The Questionnaire	11
	Treatment of Data	12
III.	ANALYSIS OF QUESTIONNAIRE DATA	13
	Types of Schools in the Survey	13
	Size of Schools in the Survey	13
	Students Enrolled in Vocational Agriculture	13
	Students of Vocational Agriculture Enrolled for a Regular Course of Mathematics	14
	Rating of the Mathematics Courses by the 44 Teachers of Vocational Agriculture	15
	Teachers of Mathematics Utilizing Practical Applications of Mathematics to Agriculture	16
	Teachers of Vocational Agriculture Offering Instruction in Mathematics	16
	Material to be Included in a Course in Mathe- matics for Students of Vocational Agriculture	17
IV.	SUMMARY	21
	Conclusions	21
	Recommendations	22
	A Suggested Course of Study in Mathematics for Students of Vocational Agriculture in Pennsylvania	23
	BIBLIOGRAPHY	43
	APPENDIX	

LIST OF TABLES

Table	Page
1. Types of Schools in Survey	13
2. Students Enrolled in Vocational Agriculture in the 44 Schools, by Grades	14
3. Students of Vocational Agriculture Enrolled for Regular Courses of Mathematics	15
4. Rating of Mathematics Courses by the 44 Teachers of Vocational Agriculture	16
5. Materials to be Included in a Course in Agricultural Mathematics, by Enterprises	17

FUNCTIONAL MATHEMATICS
FOR STUDENTS OF VOCATIONAL AGRICULTURE
IN PENNSYLVANIA

CHAPTER I

INTRODUCTION

The General Problem

The trend of present society in the utilization of modern developments is emphasizing the importance of a knowledge of functional mathematics for all groups of people. The housewife must think in terms of proportions for recipes, kilowatt hours, time-tables for canning, and number of calories and units of vitamins in diets. The owner and operator of an automobile must think in terms of installment payments, insurance, taxes, miles per hour or per gallon; and, in the not too distant future, he will have to consider wind velocities and compass deviations. The farmer now conducts his business in terms of inventories, depreciations, cost per hour of operation, pounds of milk or butterfat per cow, and number of eggs per hen. The engineer in industry must make such calculations as heat transfer, pressure losses, and expansion of materials. The tool designer and tool planner must think in terms of angles, equations and curves. The machinist must be skilled in the use of the vernier caliper and the micrometer. On the war front the pilot must correct for variation, deviation and wind-drift. The commanding officer on the bridge of a ship must make rapid calculations of height, speed and angle of a diving enemy plane, the speed of his ship, and the time required to respond to the command, "Right full rudder". One could continue to list specific and general

developments which contribute to the necessity for a knowledge of mathematics that will function for all groups in all walks of life.

If the failure to solve some of the problems of everyday life could be analyzed it would be found that much of the trouble has been a lack of knowledge of the simplest arithmetic or a failure to appreciate its application.

The need of mathematical knowledge for all groups has been increasing, but the number of pupils in high schools enrolling in courses in mathematics has been decreasing. "In 1910 more than seventy-five per cent of all high school pupils were enrolled for a class in mathematics, while in 1940 the proportion of high school pupils enrolled for a class in mathematics was less than thirty-three per cent."¹ This decrease in enrollment is probably due to the fact that the mathematics which has been taught in high schools has had a practical value to only a small group of people. "There should, in addition to the algebra-geometry-trigonometry sequence, be developed in the high school another series of offerings in mathematics for the great majority of pupils. This should be composed largely of arithmetic and its application to all phases of life, home, shop, farm, business, health, travel, transportation, social security, etc."¹ This does not mean that all pupils should become mathematicians, but it does mean that all pupils should be given a knowledge of mathematics which will enable them to utilize the modern developments to the fullest possible extent.

The neglected group of pupils which has attracted the writer's attention is that group of boys who are studying vocational agriculture

¹Douglass, Harl R. "The Double Track Plan of High School Mathematics." *The Mathematics Teacher*, Vol. 35, No. 2. February 1943. pp. 57-61.

in the public schools in Pennsylvania. This study, therefore, shall investigate the need for improved instruction in mathematics for these boys.

Setting and Need

Mathematics as a course of study has never been a requirement for pupils studying vocational agriculture in the state of Pennsylvania. Under existing conditions many pupils are being graduated in the curriculum of vocational agriculture without having had any instruction in mathematics beyond eighth grade. A few of the most progressive teachers have recognized this weakness and have incorporated agricultural mathematics in their courses.

It is generally agreed that agriculture, with its ever increasing number of specializations, requires a functional knowledge of mathematics for a maximum of success. Little information, however, can be obtained on what agricultural mathematics should comprise. Neither is there any agreement as to how or when it should be taught to pupils of vocational agriculture.

The objectives of this study, therefore, will be to determine: (1) the mathematical knowledge which is needed in the business of farming; (2) when the student of vocational agriculture should receive instruction in mathematics; (3) how mathematics could be taught in relation to agriculture; (4) who should teach mathematics to pupils of vocational agriculture.

The Problem Delimited

The emphasis in the present study will be to obtain and organize materials to be taught in a course in agricultural mathematics for

students of vocational agriculture. This will fulfill the first objective above. The other objectives will be fulfilled as a matter of course when methods and procedures to be used in teaching agricultural mathematics are recommended.

Scope of Study

This study was made on a state-wide basis in Pennsylvania. The 33 county supervisors who were sent a form letter represented 65 counties, or 96 per cent of the counties of the State. The 28 who returned the form letters represented 51 counties, or 76 per cent of the counties of the State. The 73 teachers who were sent questionnaires represented 43 per cent of the counties of the State. Those returned represented 22 counties, or 32 per cent of the counties of the State.

Review of Related Literature

Recent studies in the field of mathematics substantiate the statement that mathematics should be taught to the majority of pupils on a functional basis. Much of the material now being taught in our regular courses in mathematics is not needed to solve the problems in our vocations and everyday life. The actual abilities required by most people are far less complicated than those we try to teach in our traditional high school courses in mathematics.

Starr in his article, "Enrichment Materials for First-Year Algebra", states:

We should give to each student such a knowledge of mathematics as will enable him to carry on the work of his future occupation as it is now conducted, as will serve as a basis for future preparation if progress in his work should demand it, as will enable him to find new and better ways of doing his work and

to recognize a mathematical situation when he sees it.²

In all teaching we attempt to give students much information which they will never use. Since nature has not provided means by which the pupil long retains the information he does not use, this type of teaching reduces the retention of knowledge to almost zero.

Washburne, in "Educational Method", states:

Teach all children only that which we know all children will use. This does not preclude the vocational courses, it implies rather that all children who are going to follow a vocation that requires a given body of arithmetic should learn that material.³

He states further:

Never include in any drill material an example that you cannot put into a realistic story problem.³

Agricultural mathematics is well adapted to functional teaching in vocational agriculture. Many problems arise in the student's supervised farming program which must be solved by mathematics. The solution of these problems is purposeful, for it is used immediately. This directly coincides with the limitations of the term "functional" which Meek and Zechiel define:

To be functional an immediate purpose must be served, not a remote, unrecognized and unacceptable purpose. In other words, functional teaching is purposeful teaching in such situations that the skill or concept is learned for an immediate purpose and then is used immediately. Learning which takes place in such situations is meaningful to students, makes a lasting imprint upon them and insures a high degree of retention.⁴

²Starr, D. W. "Enrichment Materials for First-Year Algebra." The Mathematics Teacher, 32:68-77. February 1939.

³Washburne, C. W. "Functional Arithmetic." Educational Method, 16:167-70. January 1937.

⁴Meek, R. R. and Zechiel, A. M. "Functional Mathematics Teaching." Educational Research Bulletin, 19:479-82. November 20, 1940.

If mathematics is taught as a separate subject it should be correlated with the work the student is doing in his vocational course.

Carl S. Hedstrom in his book, "Vocational Mathematics in Unit Form", concludes:

When classes of students in machine shop are beginning to cut threads in the shop they can study the unit on thread cutting in mathematics.⁵

The material to be presented in mathematics must be interesting to the pupil and within his capacity to master. Mallory writes in *The Mathematics Teacher*:

The material to be presented should be that which will definitely function in the life of the pupil. It must be material of a type which will interest him through convincing him of its practical value. It is impossible to do this if the work is exactly the same type that he has had before. The material must be within the pupil's capacity to understand. Not only must this be borne in mind in the selection of the material but also in the method of presentation.⁶

Too much of our teaching has been of the type that Palmer speaks about in his book, "Practical Mathematics":

Usually when the practical man appreciates the fact for himself that mathematics is a powerful tool that he must be able to use in performing his work he finds that even the arithmetic he learned in school has left him.

R. W. Cline in his study concludes:

There is need for educational improvement in the educational program pertaining to the development of mathematical abilities among students of vocational agriculture.

⁵Hedstrom, Carl S. *Vocational Mathematics in Unit Form*. Ann Arbor, Michigan: Edwards Brothers, Inc. 1935. pp. 111-409.

⁶Mallory, Virgil S. "A Course in Mathematics for Pupils Not Going to College." *The Mathematics Teacher*, 25:340-346. October 1936.

⁷Palmer, Claude Irwin. *Practical Mathematics, Part I*. New York City: McGraw-Hill Book Company, Inc. 1918. p. 151.

Teachers of mathematics in agricultural areas should make more use of practical farm situations in their courses.

Teachers of agriculture should give more attention to evaluating and developing the abilities of their pupils to perform the mathematical operations involved in the agriculture of the region.⁸

Sources of Data

There were several possible sources of information available for this study. Successful farmers having the necessary intelligence could have provided lists of problems which they have had to solve in their farming business. County agents, with their close farmer contacts, are called upon to solve many agricultural problems in mathematics and therefore would have some knowledge of the weaknesses in mathematics of many farmers and would know the need for more specific instruction. The most logical source, however, seemed to be the teachers of vocational agriculture who have included in their course in vocational agriculture some instruction in agricultural mathematics. These teachers have close farmer contacts and are working with the group of boys which has attracted the attention of the writer.

Related literature in this general field is discussed in a preceding section. A search for related studies in the field of agricultural mathematics revealed very few. Some work has been done on vocational mathematics in the industrial field, but the only work with a direct bearing on agricultural mathematics is the study by Cline.⁸

Textbooks on agricultural mathematics were reviewed to deter-

⁸Cline, R. W. Constructing and Evaluating Practice Exercises in Mathematics for Students of Vocational Agriculture in Arizona. Thesis, Ph. D. Columbus, Ohio: The Ohio State University. 1939. p. 234.

mine the available material for teachers who wish to include instruction in mathematics in their course in vocational agriculture.

Three texts seemed to be comprehensive and practical enough for the purposes of this study. It was decided, therefore, that these three should constitute the textbook references for this study.

For an understanding of the reasons for the choice of these books a brief review is given.

The texts are: (1) "Mathematics in Agriculture" by R. V. McGee, 1942, Prentice-Hall, Inc., New York; (2) "Modern Agricultural Mathematics" by Maurice Nadler, 1942, Orange Judd Publishing Company, Inc., New York; (3) "Arithmetic in Agriculture" by Fenske, Drake and Edson, 1939, Webb Book Publishing Company, Saint Paul.

The books are similar in the following desirable features:

The subject matter has been vitalized by giving the problems their proper agricultural setting.

Each unit of mathematics presented is followed by a series of farm problems.

The artificial or puzzle-type problems have not been included.

Practicability has been the basis for the selection of problems.

The student is trained in the analysis of agricultural problems and in the application of mathematical processes to their solution.

The student becomes acquainted with some algebra, geometry and trigonometry. However, material is avoided that may be difficult for a student whose entire mathematical background consists of elementary arithmetic.

The practical relation to the subject of farming makes the subject interesting to the farm boy.

Although the textbooks are somewhat similar, they also differ in several features.

"Arithmetic in Agriculture" by Fenske, Drake and Edson provides a thorough review of the fundamental operations. Such review seems necessary for most pupils entering high school. The practice problems for this review are applications of mathematics to agriculture.

Beginning with chapter five the problems are grouped according to agricultural enterprises. This feature increases the student's interest and enables the teacher to integrate mathematics with the agricultural subjects.

"Modern Agricultural Mathematics" by Nadler assumes that the student does not need any review in the fundamental operations. The first seven chapters are devoted to an introduction of algebra, geometry and trigonometry which will be helpful in solving mathematical problems in agriculture. Like Fenske, the problems for practice in this introduction are applications of mathematics to agriculture.

Part two of this text is devoted to mathematical problems in agriculture grouped according to enterprises.

"Mathematics in Agriculture" by McGee makes use of an entirely different presentation from either of the other two texts. It presents a mathematical operation, theorem or formula and develops its solution. The practice problems which follow are applications of the principle involved and are drawn from all farming enterprises.

Procedure

The names of the teachers of vocational agriculture who are offering a course in agricultural mathematics were secured from the county supervisors. A form letter, a copy of which can be found in the appendix, was prepared and a copy sent to each of the 33 county supervisors on July 11, 1944. Twenty-eight, or 85 per cent, of the supervisors returned the form letters. Eight of the supervisors stated that there were no teachers in their districts who were offering a course in agricultural mathematics. The other 20 supervisors listed 73 teachers who were offering mathematics either as a separate course or integrated with their other agricultural subjects.

On August 1, 1944 each of the 73 teachers listed was sent a questionnaire, a copy of which can be found in the appendix, and which is explained in the next chapter. Forty-four, or 60 per cent, of the questionnaires were returned. The data from these returns were analyzed and summarized.

CHAPTER II

COLLECTION AND TREATMENT OF DATA

The Questionnaire

A questionnaire was prepared for the purpose of obtaining information on this problem. The title is: "Survey of Mathematics Instruction Received by Students of Vocational Agriculture in Pennsylvania."⁹ Sections one and two required the filling in of number of students enrolled. Sections three, four, five and six were prepared as a check list. The six sections are as follows:

1. Number of students enrolled in vocational agriculture.
2. Number of students enrolled in each of the mathematics courses offered.
3. The value of mathematics courses to students of vocational agriculture.
4. The number of mathematics teachers who utilize the practical applications of mathematics to agriculture as a part of their courses.
5. The number of teachers of vocational agriculture who include definite organized instruction in mathematics as a part of their regular courses in vocational agriculture.
6. The mathematical material which should be included as a part of a course of vocational agriculture.

The first draft of the questionnaire was submitted to the

⁹A copy may be found in the appendix.

Agricultural Education Department, The Pennsylvania State College, for criticism and suggestions. After the final approval of the questionnaire, copies were sent to teachers of agriculture, as explained in "Procedure" in Chapter I. A form letter explaining the purpose of the survey accompanied each questionnaire. Copies of the questionnaire form and the letter of transmittal are included as Appendix B and Appendix C.

Forty-four, or 60 per cent, of the questionnaires were returned.

Treatment of Data

The questionnaires were filed in the order in which they were returned. Two charts were prepared for the tabulation of the data. On chart number one the students enrolled in vocational agriculture and the students enrolled in the various mathematics courses were recorded. This was done by listing each grade and high school mathematics course across the top of the page and listing the responses on the right-hand side of the page. Opposite each response the number of students enrolled in each grade or course was listed in the column headed by that particular grade or course.

Teachers' valuation of the present high school courses in mathematics were recorded on chart two. This was done by placing the headings, "very valuable", "valuable", "of no value", across the top of the page and the courses along the right-hand side of the page.

The responses to sections four, five and six were tabulated on a copy of the questionnaire.

CHAPTER III

ANALYSIS OF QUESTIONNAIRE DATA

The information from the 44 questionnaires received from teachers of vocational agriculture is the source of data for this entire chapter.

Types of Schools in the Survey

The schools in this survey were representative of the schools of the state of Pennsylvania, for they range from a three-year high school of grades nine to eleven, to a six-year junior-senior high school.

Table 1 - Types of Schools in Survey.

Types	Number
Six-year junior-senior high schools	21
Three-year senior high schools	2
Four-year senior high schools	16
Six-year vocational high schools	2
Four-year vocational high schools	2
Three-year high schools, grades nine to eleven	1
Total	44

Size of Schools in the Survey

The schools in the survey ranged in size from an enrollment of 34 to an enrollment of 1613. The mean for these schools was 400 pupils. The median was 266 pupils.

Students Enrolled in Vocational Agriculture

The total number of students enrolled in vocational agricul-

ture in the 44 schools for the year 1944-1945 was 1429. These were distributed through the four grades as follows: 451 or 31.6 per cent were in ninth grade, 430 or 30.1 per cent were in tenth grade, 302 or 21.1 per cent were in eleventh grade, and 246 or 17.2 per cent in twelfth grade.

Table 2 - Students Enrolled in Vocational Agriculture in the 44 Schools, by Grades.

Grade	Number of students	Per cent
9	451	31.6
10	430	30.1
11	302	21.1
12	246	17.2
Total	1429	100.0

Students of Vocational Agriculture
Enrolled for a Regular Course of Mathematics

Agricultural mathematics was taught to students of vocational agriculture in 27.8 per cent of the schools and general mathematics in 63.8 per cent of the schools from which data were secured. General mathematics is a course organized to give the student who has a limited aptitude for mathematics the fundamental processes which are within his capacity to learn and which are useful to the average citizen.

The survey revealed that a considerable number of boys enrolled in vocational agriculture in the 44 schools were enrolled for a course in mathematics. The two courses which attracted the largest number of boys were general mathematics, 341 or 23.9 per cent of the boys, and agricultural mathematics 225 or 15.7 per cent of the boys. It must be pointed out that the larger number of boys enrolled in gen-

eral mathematics is accounted for by the fact that it was offered in many schools in which agricultural mathematics was not available. Where both were offered agricultural mathematics attracted 136 or 71.2 per cent of the vocational agriculture boys while general mathematics attracted only 82 or 43 per cent of the boys. Algebra one and plane geometry were next, with 185 and 115 respectively. As you would suppose, algebra two, solid geometry, and trigonometry attracted the least number of boys.

Table 3 - Students of Vocational Agriculture Enrolled for Regular Courses of Mathematics.

Course	Students		Schools	
	Number	Per cent	Number	Per cent
General mathematics	341	23.9	30	63.8
Algebra I	185	12.9	29	60.4
Algebra II	59	4.1	12	25.5
Plane geometry	115	8.1	20	42.6
Solid geometry	12	.8	5	10.6
Trigonometry	8	.6	5	10.6
Agricultural mathematics	225	15.7	13	27.8
Total	945	66.1		

Rating of the Mathematics Courses by
the 44 Teachers of Vocational Agriculture

Thirty-four or 77.2 per cent of the teachers in the survey checked agricultural mathematics as "very valuable" for students of vocational agriculture. General mathematics received the next highest number of checks, 29, which was 66 per cent of the teachers surveyed. Only three teachers checked algebra one and plane geometry as being very valuable, while only one checked algebra two, and none checked either solid geometry or trigonometry. Table 4 indicates that the

teachers rate the mathematics courses for students of vocational agriculture in order of importance as follows: agricultural mathematics, general mathematics, algebra one, plane geometry.

Table 4 - Rating of Mathematics Courses by the 44 Teachers of Vocational Agriculture.

Course	Very valuable		Valuable		Of no value	
	Number	Per cent	Number	Per cent	Number	Per cent
General mathematics	29	66.0	13	29.5	0	0
Algebra I	3	6.8	27	61.3	8	18.1
Algebra II	1	2.2	12	27.2	24	54.5
Plane geometry	3	6.8	21	47.7	11	25.0
Solid geometry	0	0	10	22.7	22	50.0
Trigonometry	0	0	8	18.1	27	61.3
Agricultural mathematics	34	77.2	5	11.3	0	0

Teachers of Mathematics Utilizing Practical Applications of Mathematics to Agriculture

Teachers of mathematics in rural areas have not been utilizing the practical applications of mathematics to agriculture. Only 50 per cent of the agriculture teachers in the survey reported that the mathematics teachers were using such applications; 40.9 per cent reported not using applications, and 9.1 per cent were not reported.

Teachers of Vocational Agriculture Offering Instruction in Mathematics

Teachers of vocational agriculture have not been offering instruction in agricultural mathematics either as a subject or integrated with the other agricultural subjects. Twenty-three teachers, only 52 per cent of those surveyed, reported that mathematics was a definite part of their instruction; 43.1 per cent reported that it was not a part of their instruction, and 4.5 per cent did not report this item.

Material to be Included in a Course in Mathematics
for Students of Vocational Agriculture

Table 5 indicates that there is agreement among teachers of vocational agriculture as to the content of a course in agricultural mathematics. The lowest number of teachers checking any item in the table was 23, or 52 per cent, while the highest was 44, or 100 per cent. The mean is 36.2 and the median is 38.5.

Table 5 - Materials to be Included in a Course in Agricultural Mathematics, by Enterprises.

Item	Times checked	Per cent
<u>Dairy</u>		
Figuring production records	44	100
Standardizing milk and cream	23	52
Computing butterfat in milk and cream	41	93
Calculating herd production averages	41	93
Using ration tables for feeding dairy cows	38	86
Evaluating feeds to be purchased	41	93
Keeping feeding records	41	93
Calculating the annual amount of roughage that will be needed on the dairy farm	40	91
Calculating the size of barn required	34	77
Figuring gestation periods	37	84
<u>Livestock</u>		
Calculating rations	37	84
Determining the quantities of feed needed	38	86
Estimating shrinkage in shipping	26	59
Determining dressing percentage	37	84
Analyzing the value of margin in feeding livestock	33	75
Using the corn-hog ratio	32	73
<u>Poultry</u>		
Calculating the number of birds that may be placed in a building	37	84
Determining the feeding space required for a flock of birds	38	86
Estimating roosting space for a pen of birds	37	84
Figuring number of nests required for a pen of birds	39	89

(Continued)

Table 5 - (Continued)

Item	Times checked	Per cent
<u>Poultry</u>		
Calculating the number of lighting units required per pen for artificial illumination	35	80
Determining per cent of production	38	86
Calculating the average number of eggs per bird	37	84
Determining the cost of producing a dozen of eggs	39	89
Figuring the cost of rearing one pullet	38	86
Calculating the percentage of hatchability	29	66
<u>Crops, Soils and Fertilizers</u>		
Determining the cost of production per acre or other unit of production	37	84
Comparing cost of plant food in fertilizers of different analysis	38	86
Using farm level in laying tile and laying out contour lines	30	68
Estimating amount of grain in a bin, hay or straw in a mow, silage in a silo	39	89
Calculating corn acreage required to fill a silo	33	75
Determining the amount of seed required to plant a given acreage	36	82
Calculating the amount of fertilizer for a given acreage	36	82
Determining the percentage of germination	34	77
Using proportion in mixing sprays	37	84
Learning the meaning of fertilizer formulas	39	89
<u>Farm Engineering</u>		
Calculating board feet	40	91
Figuring bill of materials	40	91
Measuring rafters	39	89
Estimating the board feet in a standing tree	34	77
Determining the amount of paint to cover a given surface	38	86
Calculating the amount of cement and aggregate required for a given concrete structure	39	89
Reading an electric meter	38	86
Calculating the cost of operating an electric appliance	38	86
Drawing to scale	38	86
Measuring for pipe fitting	35	80

(Continued)

Table 5 - (Continued)

Item	Times checked	Per cent
<u>Farm Economics and Farm Management</u>		
Reading and constructing graphs	37	84
Learning to interpret market quotations	39	89
Making a farm inventory	41	93
Keeping farm accounts	42	95
Calculating labor income	39	89
<u>Financing the Farm Business</u>		
Writing a check	39	89
Using promissory notes	39	89
Buying on the installment plan	39	89
Calculating interest	41	93
Saving money	38	86
Buying insurance	41	93
Paying taxes	40	91
Using amortization payments	34	77

In the space provided on the questionnaire for the teachers to "list others", the following items in the several enterprises were listed:

Dairy

Estimating expenses and receipts as in project books.

Cost of raising heifers.

Comparative cost of artificial insemination.

Livestock

Find the approximate weight of cattle by measurement tables.

Crops, Soils and Fertilizers

Determining amount of lime required per acre from PH scale values.

Determining harvesting costs.

Farm Engineering

Calculations for building steps.

Cost of wiring farm buildings.

Determining tap or die to use.

Estimating bundles of shingles, rolls of roofing paper, sheets of galvanized iron, or rolls of tin for a given roof.

Calculate cords of wood.

Determine rolls of wall paper for a given room.

How to purchase hardware such as nails, bolts, screws and hinges.

Figuring pulley speeds.

Determining horse power.

Farm Economics and Farm Management

Calculate farm income.

Calculating interest.

Figuring crop index.

Value of farm conveniences.

Economic value of home improvement.

Calculating man labor.

Determine the value of food used from the farm when comparing farm income with city income.

Analyzing the year's business.

Financing the Farm Business

Writing a bill of sale.

Writing a contract.

Use of short term credit.

Calculating the fire insurance to carry.

Use of Government credit.

CHAPTER IV

SUMMARY

Conclusions

The facts obtained from the questionnaire and previous studies seem to justify the following conclusions:

1. Present day farming requires a functional knowledge of mathematics.
2. Agricultural mathematics is taught in only a small percentage of the high schools in Pennsylvania.
3. A considerable number of students in vocational agriculture have recognized the value of mathematics and, where possible, have enrolled for one or more courses in mathematics.
4. Agricultural mathematics, where it was taught, attracted a greater percentage of vocational agriculture students than any other mathematics course in the schools surveyed.
5. General mathematics ranked next to agricultural mathematics in the percentage of vocational agriculture students it attracted in the schools surveyed.
6. Algebra one and plane geometry attracted a few of the vocational agriculture students.
7. Algebra two, solid geometry, and trigonometry attracted very few students of vocational agriculture.
8. The majority of teachers of vocational agriculture recognize the value of related mathematics to students of vocational agriculture.
9. Teachers of vocational agriculture rank the regular courses

in mathematics, i. e. courses other than agricultural mathematics, with respect to their value for students of vocational agriculture in the following order: (1) general mathematics, (2) algebra one, (3) plane geometry. Most teachers consider algebra two, solid geometry, and trigonometry of no value for students of vocational agriculture.

10. Too few mathematics teachers in rural areas are utilizing practical applications of mathematics to agriculture.

11. There is considerable agreement among teachers concerning the instruction in mathematics which students of vocational agriculture should receive.

12. Few teachers of vocational agriculture are offering instruction in mathematics either as a course or integrated with their regular courses.

13. Most teachers of vocational agriculture who do teach mathematics integrate it with their agriculture courses.

Recommendations

1. More teachers of mathematics in rural areas should utilize practical applications of mathematics to agriculture.

2. More teachers of vocational agriculture should offer instruction in agricultural mathematics.

3. Students of vocational agriculture should be encouraged to enroll in mathematics courses.

4. Agricultural mathematics should be taught on a functional basis.

5. A course of study in mathematics making use of applica-

tions to agriculture should be used in the high schools where vocational agriculture is taught.

A Suggested Course of Study in Mathematics for
Students of Vocational Agriculture in Pennsylvania

Introduction

This series of lessons in agricultural mathematics was prepared to aid teachers in integrating mathematics with vocational agriculture in Pennsylvania. The course in mathematics is suggested as a pattern. This course has been adapted to a particular teaching situation but it is believed that it will have application throughout the state of Pennsylvania. It is understood, of course, that every teacher will improve the suggested course by using examples and applications drawn from his own community situation.

Lessons in each enterprise which provide specific opportunities for teaching mathematics have been selected. A list of practice exercises and a sample problem have been included for each enterprise. Other sample problems and practice exercises can be found in the references listed with each lesson.

The lessons were prepared for use with the references listed below. The teacher should secure the three agricultural mathematics books and use his own texts in the agricultural enterprises for further references.

List of References for the Suggested
Course in Agricultural Mathematics

The references suggested as specific for the various topics in the accompanying lessons are by numbers in accordance with this list.

Reference
number

1. FENSKE, T. H., DRAKE, R. M. and EDSON, A. W., General Editor
FIELD, A. M. Arithmetic in Agriculture. Saint Paul: Webb
Book Publishing Company. 1939. pp. x+243.
2. NADLER, MAURICE. Modern Agricultural Mathematics. New York:
Orange Judd Publishing Company, Inc. 1942. pp. v+315.
3. MCGEE, R. V. Mathematics in Agriculture. New York: Prentice-
Hall, Inc. 1942. pp. v+189.
4. COFFEY, JOEL S. and JACKSON, LYMAN E. Livestock Management.
Philadelphia: J. B. Lippincott Company. 1940. pp. xi+500.
5. CHAPMANN, PAUL W. and SHEFFER, L. M. Livestock Farming.
Atlanta: Turner E. Smith and Company. 1936. pp. ix+720.
6. ANDERSON, ARTHUR L. Swine Enterprises. Philadelphia: J. B.
Lippincott Company. 1938. pp. ix+458.
7. VAUGHN, H. W. Types and Market Classes of Livestock.
Columbus, Ohio: R. G. Adams and Company. 1935. pp. 574.
8. McDOWELL, JOHN C. and FIELD, ALBERT M. Dairy Enterprises.
Philadelphia: J. B. Lippincott Company. 1936. pp. vii+471.
9. RICE, JAMES E. and BOTSFORD, HAROLD E. Practical Poultry
Management. New York: John Wiley and Sons, Inc. 1940.
pp. xix+604.
10. KNANDEL, H. CLYDE. Profitable Poultry Keeping. New York:
Orange Judd Publishing Company. 1943. pp. xx+462.
11. JULL, MORLEY A. Poultry Husbandry. New York: McGraw-Hill
Book Company, Inc. 1938. pp. viii+548.
12. DAVIS, KARY C. and OTHERS. Field Crop Enterprises. Phila-
delphia: J. B. Lippincott Company. 1937. pp. xxvii+552.
13. COOK, G. C., SCRANTON, L. L. and MCCOLLY, H. F. Farm
Mechanics Text and Handbook. Danville, Illinois: Inter-
state Printing Company. 1937: pp. 450.
14. DAVIS, KARY C. and OTHERS. Farm Enterprise Mechanics.
Philadelphia: J. B. Lippincott Company. 1935. pp. vii+408.
15. WRIGHT, FORREST B. Rural Water Supply and Sanitation. New
York: John Wiley and Sons, Inc. 1939. pp. xi+288.
16. OVERTON, MILLARD HERBERT and ROBERTSON, LYNN SHELBY. Farm
Management and Marketing. Philadelphia: J. B. Lippincott
Company. 1936. pp. xi+431.

Lessons in the Dairy Enterprise which Provide
Specific Opportunity for the Teaching of Mathematics

Lessons	References
Figuring production records (See sample problem below.)	(1) pp. 124-125
Standardizing milk and cream	(1) pp. 126-129 (2) pp. 148-155
Computing butterfat in milk and cream . . .	(1) pp. 129-131 (2) p.138
Calculating herd production averages . . .	(1) pp. 132, 137 (2) pp. 140-141
Using ration tables for feeding dairy cows	(1) pp. 137-140
Evaluating feeds to be purchased	(2) pp. 162-165
Keeping feeding records	(8) p. 177
Calculating the annual amount of roughage which will be needed on the dairy farm .	(1) pp. 152-156
Calculating the size of barn required . .	(16) p. 154
Figuring gestation tables	(1) p. 175 (8) p. 340
Cost of raising a heifer	(1) p. 145

Sample Problem

Dairying is an important farm enterprise. The sale of its products provides many farmers with the major part of their income. To realize the greatest profit from his dairy herd the farmer must be familiar with good feeding and good management practices. Is he realizing the greatest income on his money invested, is the question which he must answer. Mathematics must be used to obtain the answer to this question.

Figuring Production Records

AMOUNT OF MILK.--The first step in figuring the amount of

milk of an individual cow is to determine the amount produced for a given period, usually a month. This can be done by two methods:

1. Recording the weight of the milk produced daily and totaling at the end of the month.
(Recommended only if you have the use of an adding machine.)
2. Weigh the milk for one day, assume this to be the daily average production, and multiply by the number of days in the month.

Example, Method 2:

William's project heifer produced 30 pounds of milk on July 15. How much milk did she produce for the month of July?

Solution:

Production per month = Days in month x Daily production

Production per month = 31 x 30

Production per month = 930 pounds of milk for July

Find the amount of milk produced for the month of July by the following cows:

1. 40 lbs. of milk daily
2. 35 lbs. of milk daily
3. 47 lbs. of milk daily
4. 50 lbs. of milk daily

AMOUNT OF BUTTERFAT.—Milk is usually sold on the butterfat content basis; that is, the market price is determined by the amount of butterfat the milk contains. Therefore it becomes necessary for the dairy farmer to determine the butterfat content of an individual cow's

milk if he wishes to calculate the value of her product. The percentage of butterfat is determined by the Babcock test. Arithmetic must then be used to determine the pounds of butterfat in a given quantity of milk.

Pounds of butterfat = Pounds of milk multiplied by the per cent of butterfat.

Example:

Find the amount of butterfat produced by William's project heifer for the month of July if she produced 930 pounds of milk testing 4.2 per cent butterfat.

Solution:

Pounds of butterfat = Pounds of milk x Per cent of butterfat

Pounds of butterfat = $930 \times 4.2\%$

$$\begin{array}{r} 930 \\ .042 \\ \hline 1860 \\ 3720 \\ \hline 39.060 \end{array}$$

Pounds of butterfat = 39.1

Find the amount of butterfat produced by the following cows for the month of July:

1. 1240 lbs. of milk testing 3.8%
2. 1085 lbs. of milk testing 4.0%
3. 1457 lbs. of milk testing 4.1%
4. 1550 lbs. of milk testing 3.7%

VALUE OF MILK.--Whole milk is usually sold wholesale at a certain price per 100 pounds of 4.0 per cent butterfat. This is known as the base price. A premium is added for milk testing more than 4.0

per cent butterfat and a flat rate is deducted from the base price for milk testing less than 4.0 per cent. The common practice is to pay a premium of four cents (\$.04) per hundred pounds more than the base price for each tenth of a point the milk tests more than 4.0 per cent and subtract four cents (\$.04) per hundred pounds from the base price for each tenth of a point the milk tests less than 4.0 per cent. The term "differential" is given to that amount which is added to the base price for each tenth of a point the test is more than 4.0 per cent or subtracted for each tenth of a point the test is less than 4.0 per cent. (The value varies from company to company and from time to time.)

1. For milk testing more than 4.0 per cent subtract 4.0 per cent from the actual test, multiply by the differential, add this product to the base price.
2. For milk testing less than 4.0 per cent subtract the actual test from 4.0 per cent, multiply by the differential, subtract this product from the base price.

Example 1:

Calculate the value of the milk from William's project heifer if she produced 930 pounds of milk testing 4.2 per cent, when the differential is \$.04 and the base price is \$2.00.

Solution:

Actual test - 4.0%

$$4.2 - 4.0 = 2$$

Differential x Difference

$$$.04 \times 2 = $.08$$

Base price + Product of the differential and difference

$$\$2.00 + \$.08 = \$2.08 \text{ Price per cwt. for 4.2\% milk}$$

$$\text{Value} = \text{Price per cwt.} \times \text{Cwt.}$$

$$\text{Value} = \$2.08 \times 9.30$$

$$\text{Value} = \$19.34$$

Example 2:

Find the value of the milk produced by Bruce's project heifer for the month of July when she produced 1432 pounds of milk testing 3.6 per cent. The base price is \$2.00 and the differential is \$.04.

Solution:

$$4.0 - \text{Actual test}$$

$$4.0 - 3.6 = 4$$

$$\text{Differential} \times \text{Difference}$$

$$\$0.04 \times 4 = \$0.16$$

$$\text{Base price} - \text{Product of the differential and difference}$$

$$\$2.00 - \$0.16 = \$1.84 \text{ Price per cwt. for 3.6\% milk}$$

$$\text{Value} = \text{Price per cwt.} \times \text{Cwt.}$$

$$\text{Value} = \$1.84 \times 14.32 = \$26.35$$

Find the value of the milk produced by the following cows if the differential is \$.04 and the base price is \$3.76:

1. 1240 lbs. of milk testing 3.3%
2. 1085 lbs. of milk testing 4.0%
3. 1457 lbs. of milk testing 4.1%
4. 1550 lbs. of milk testing 3.7%

Lessons in the Livestock Enterprise
Which Provide Specific Opportunity
for the Teaching of Mathematics

Lessons	References
Using the corn-hog ratio (See sample problem below.)	(1) pp. 159-60 (4) pp.10,356 (5) p. 308 (6) p. 383
Analyzing the value of margin in feeding livestock	(1) pp. 157-159 (4) pp.94-96 (7) pp. 113-114
Determining dressing percentage	(1) p. 161 (7) p. 50 (2) p. 130
Estimating shrinkage in shipping	(1) p. 160 (4) p. 194 (7) pp.371-373
Determining quantities of feed needed . .	(1) pp. 154-156
Calculating rations	(1) pp. 149-153 (4) pp.425-427

Sample Problem

The production of livestock is an indirect method of marketing farm crops. To realize the greatest profit from this enterprise the farmer must compare the farm value of the crops with the farm value of the livestock product he is producing. Mathematics must be used for this comparison.

Corn-Hog Ratio

The corn-hog ratio is the relationship of the price of 100 pounds of hogs as compared with the price of one bushel of corn. In theory, when the corn-hog ratio is greater than 10 it will be profitable to feed the corn to hogs and when it is less than 10 it will be profitable to market the corn directly.

$$\text{Corn-hog ratio} = \frac{\text{Price per cwt. of hogs}}{\text{Price per bu. of corn}}$$

Example:

In November 1944 the farm price of hogs was \$15.30 per cwt. and the farm price of corn was \$1.07 per bushel. Find the corn-hog ratio. Would it be profitable to feed the corn to hogs under these conditions?

Solution:

Corn-hog ratio = Price per cwt. of hogs ÷ Price per bu. of corn

$$\text{Corn-hog ratio} = 15.30 \div 1.07$$

$$\begin{array}{r} 1.07 \overline{) 15.30} \\ \underline{10\ 7} \\ 4\ 60 \\ \underline{4\ 28} \\ 320 \\ \underline{214} \\ 1060 \\ \underline{963} \end{array}$$

$$\text{Corn-hog ratio} = 14.3$$

Under these conditions, because the ratio is greater than 10, it would be profitable to feed the corn to hogs.

Calculate the corn-hog ratio for the following conditions and state whether it would be profitable to feed the corn to hogs:

1. In August 1945 the farm price of hogs was \$15.00 per cwt. and the farm price of corn was \$1.40 per bu.
2. In June 1944 the farm price of hogs was \$14.40 per cwt. and the farm price of corn was \$1.09 per bu.
3. In February 1941 the farm price of hogs was \$7.70 per cwt. and the farm price of corn was \$.95 per bu.
4. In November 1940 the farm price of hogs was \$6.30

per cwt. and the farm price of corn was \$.70 per bu.

5. In February 1943 the farm price of hogs was \$17.10
per cwt. and the farm price of corn was \$1.30 per bu.

Lessons in the Poultry Enterprise
Which Provide Specific Opportunity
for the Teaching of Mathematics

Lessons	References
Calculate the number of birds that may be placed in a building	(9) p. 82 (10) pp. 191-192 (11) pp. 187, 213
Determine the feeding space required for a flock of birds	(9) p. 66 (10) pp. 151-165
Estimating roosting space for a pen of birds	(9) p. 55 (10) p. 243 (11) p. 223
Figuring number of nests required for a pen of birds	(9) p. 59 (10) p. 244
Calculating the number of lighting units required per pen for artificial illumination	(9) p. 161 (10) p. 173 (11) p. 213
Determining the per cent of production . .	(9) p. 199
Calculating the average number of eggs per hen	(9) p. 199 (2) p. 255
Determining the cost of producing a dozen of eggs	(9) p. 207
Figuring the cost of rearing one pullet . .	(9) p. 205
Calculating the per cent of hatchability . (See sample problem below.)	(10) pp. 68-69

Sample Problem

For a business to yield a profit it is necessary for the cost of production to be less than the selling price of the article produced. The spread between these two values is determined by many factors in

the poultry enterprise. To keep the cost of production at a minimum, records must be kept and analyzed so that each factor may be reduced as much as possible.

Per Cent of Hatchability

Per cent of hatchability is an important factor in the cost of hatching chicks. Most hatcherymen set their goal at 60 per cent hatchability or better. Per cent of hatchability is found by dividing the number of strong, healthy chicks produced on the twenty-first day by the number of eggs set, and multiplying by 100.

$$\text{Per cent hatchability} = \frac{\text{Number of chicks}}{\text{Number of eggs set}} \times 100$$

Example:

Mr. Wallace set 12,000 eggs on March 1. He took 8,760 strong, healthy chicks from the hatcher on March 21. What was his per cent of hatchability?

Solution:

$$\% H. = \frac{\text{Chicks}}{\text{Eggs}} \times 100$$

$$\% H. = \frac{8,760}{12,000} \times 100$$

$$\begin{array}{r} \overline{) 8,760.00} \\ \underline{8,400 } \\ 360 \\ \underline{360 } \\ 0 \end{array}$$

$$\% H. = .73 \times 100$$

$$\% H. = 73\%$$

Calculate the per cent hatchability of the following:

1. 64,000 eggs set and 36,475 chicks hatched
2. 24,500 eggs set and 18,470 chicks hatched

3. 6,000 eggs set and 2,796 chicks hatched
4. 10,000 eggs set and 7,986 chicks hatched
5. 15,600 eggs set and 7,840 chicks hatched

Lessons in the Crops Enterprise
Which Provide Specific Opportunity
for the Teaching of Mathematics

Lessons

References

- Determining the cost of production per
acre, bushel or other unit of production .
(See sample problem below.)
- Comparing the cost of plant food in
fertilizers of different analysis (2) pp. 130, 202-203
(3) pp. 16-18, 135-139, 169
- Using farm level in laying tile and
laying out contour lines (12) pp. 514-518
- Estimating the amount of grain in a bin,
hay or straw in a mow, silage in a silo . (2) pp. 60-64, 73-74, 76-79
(3) pp. 124-129 (12) p. 69
(1) pp. 53-66
- Value of farm manure (2) pp. 196-199
- Calculating acreage (2) p. 28
- Calculating the corn acreage
to fill a silo
- Plants per acre (2) pp. 46-49
- Determining the amount of seed
to plant a given acreage (1) pp. 110-116 (2) pp. 46-56
(12) pp. 112, 178, 531
- Calculating the amount of fertilizer
required for a given acreage (1) pp. 116-123
- Determining the per cent of germination . .
- Using proportion in mixing sprays (3) pp. 29-30
- Learning the meaning of
fertilizer formulas (1) pp. 116-123 (2) pp. 200-203
(3) pp. 16, 135-139, 169

Sample Problem

Profit can not be determined until the cost of production is known. In the field crop enterprise there are a number of factors which contribute to the cost of production, i. e. labor, seed, fertilizer, manure, land rental, interest on investment, use of machinery.

Cost of Producing a Bushel of Corn

The modern farmer is interested to know how much it costs him to produce a bushel or an acre of corn. He knows that the cost will determine the price at which he can sell his crop at a profit.

To determine the cost of producing a bushel of corn the total cost must be divided by the total yield in bushels.

$$\text{Cost per bushel} = \text{Total Cost} \div \text{Total yield}$$

Example:

The following figures were taken from a project book for the year 1944. Find the cost of producing one bushel of corn.

Solution:

Rental of equipment	\$ 2.40
Seed	1.97
Manure	30.00
Land rental	133.50
Interest on investment	.39
Self labor	.80
Other man labor and power labor . . .	15.75
Total	<u>\$188.81</u>
Total yield	178 bushels
Cost per bu. = Total cost $\div$ Total yield	

Cost per bu. = \$188.81 ÷ 178

178

188.81

178

10 81

10 68

1300

1246

540

534

6

Cost per bu. = \$1.06

Calculate the cost of producing one bushel of the following:

1.

Total cost \$28.55, total production 120 bu. corn
2.

Total cost \$42.40, total production 190 bu. corn
3.

Total cost \$133.61, total production 800 bu.potatoes
4.

Total cost \$41.40, total production 40 bu. wheat
5.

Total cost \$19.18, total production 30 bu. corn

Lessons in the Farm Engineering Enterprise
Which Provide Specific Opportunity
for the Teaching of Mathematics

Lessons	References
Laying tile drains	(2) pp. 5-6
Fencing	(2) pp. 5, 24
Calculating cords of wood	(2) pp. 64-65
Calculating board feet	(1) pp. 167-173 (2) pp.89-94 (3) p. 122 (13) p. 78
Figuring bill of materials	(13) pp. 77-80 (2) p. 92
Measuring rafters (See sample problem below.)	(1) pp. 170-171 (13) pp.107-110 (14) p. 159 (2) pp.122-123
Estimating the board feet in a standing tree	(1) pp. 167-168 (2) pp.94-100 (3) pp. 122-124
Determining the amount of paint to cover a given surface	(1) pp. 173-175 (2) p. 34

Lessons

References

- Calculating r. p. m. of pulleys (2) pp. 217-220
- Calculating the cement and
aggregate for a given structure (1) pp. 176-180 (2) pp. 62-63,
228-237 (3) pp. 120-122
(13) p. 224 (14) pp. 68-69
- Reading an electric meter (1) pp. 183-186
- Calculating the cost of
operating an electric appliance (1) pp. 183-186 (2) pp. 225-227
- Drawing to scale (2) pp. 80-88 (13) pp. 81-88
- Measuring for pipe fitting (15) pp. 1-3
- Levers and mechanical advantage (2) pp. 213-217

Sample Problem

The increase in mechanization on the farm has resulted in a demand for a greater knowledge of farm engineering. The farmer who is mechanically minded can make repairs and constructions at a great saving of money and labor.

Determining Length of Rafters

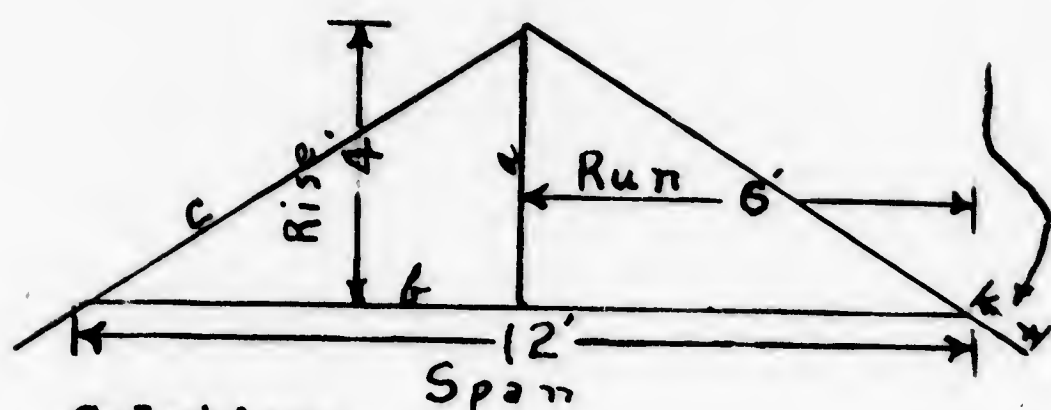
In simple structures such as range shelters and colony houses the farmer can save time and money if he knows how to determine the length of rafters required.

Rafters complete a right triangle in which the following relationship is true. The square of the hypotenuse is equal to the sum of the squares of the other two sides. Stated in terms of the sides of the triangle it becomes: $c^2 = a^2 + b^2$

Example:

Find the length of the rafters required for the roof of a building with a rise of 4 feet and a span of 12 feet and an

overhang of 12 inches.



Solution:

$$\text{Run} = 1/2 \text{ the span}$$

$$c^2 = a^2 + b^2$$

$$c^2 = (4)^2 + (6)^2$$

$$c^2 = 16 + 36$$

$$c^2 = 52$$

$$c = \sqrt{52}$$

$$c = 7.211 \text{ ft.}$$

$$\text{Rafter} = c + \text{Overhang}$$

$$\text{Rafter} = 7.211 + 1$$

$$\text{Rafter} = 8.211 \text{ ft.}$$

Calculate the length of the rafters required for the following buildings:

1. Rise of 5 ft., span of 13 ft., overhang of 18 in.
2. Rise of 6 ft., span of 15 ft., overhang of 15 in.
3. Rise of 15 ft., span of 46 ft., overhang of 2 ft.
4. Rise of 8 ft., span of 20 ft., overhang of 10 in.
5. Rise of 10 ft., span of 25 ft., overhang of 14 in.

Lessons in Farm Economics and Farm Management
Which Provide Specific Opportunity
for the Teaching of Mathematics

Lessons	References
Reading and constructing graphs	(1) pp. 189-196 (2) pp.258-265 (3) pp. 95-116
Learning to interpret market quotations . .	(1) pp. 196-199
Making a farm inventory	(1) p. 205 (2) pp. 246-249
Keeping farm accounts	(1) pp. 205-211 (2) pp.249-252
Calculating labor income (See sample problem below.)	(1) pp. 207-208 (2) pp.252-253

Sample Problem

Successful farmers conduct their farms on a strictly business basis the same as a manufacturing company or a retail store. Market quotations must be studied, records must be kept, and the best approved practices of livestock and crop management must be followed.

Calculating Labor Income

From the records which the farmer keeps he can calculate his labor income, or the amount of money which is the result of his own efforts.

Example:

Find the operator's labor income on a farm where cash receipts are \$9765, cash expenses \$4123, unpaid family labor \$375, farm produce used at home \$500, opening inventory \$22800, closing inventory \$23950, and interest on investment 5 per cent.

Solution:

Increase in inventory is always added to receipts.

Decrease in inventory is always added to the expenses.

Interest is figured on the opening inventory.

Opening inventory	\$22,800	Cash expenses	\$4,123
Closing inventory	23,950	Interest on	
Increase in		investment	1,140
inventory	\$ 1,150	Family labor	375
Cash receipts	\$ 9,765	Total debits	\$5,638
Farm produce			
used at home	500		
Total receipts	\$10,265		
Total debits	5,638		
	\$ 4,627	= Operator's labor income	

Find the operator's labor income from the following farm records:

1. Cash receipts \$5976, cash expenses \$2143, unpaid family labor \$63, produce used at home \$75, opening inventory \$9432, closing inventory \$8674, interest on investment 4 per cent.
2. Cash receipts \$12786, cash expenses \$7956, unpaid family labor \$375, produce used at home \$263, opening inventory \$32674, closing inventory \$34000, interest on investment 5 per cent.
3. Cash receipts \$15605, cash expenses \$10000, unpaid family labor \$467, produce used at home \$388, opening inventory \$42000, closing inventory \$41000, interest on investment 6 per cent.

Lessons in Financing the Farm Business
Which Provide Specific Opportunity
for the Teaching of Mathematics

Lessons	References
Writing a check	(1) pp. 80-84
Using a promissory note	(1) pp. 84-86 (2) pp.244-245
Buying on the installment plan	(1) pp. 87-89 (2) pp.243-244
Calculating interest	(1) pp. 89-94 (2) pp.238-243
Saving money	(1) pp. 95-98
Buying insurance	(1) pp. 98-104
Paying taxes	(1) pp. 104-106 (2) p. 130
Using amortization payments (See sample problem below.)	(1) pp. 96-98
Personal accounts	(1) pp. 106-109
Commission selling	(2) p. 130

Sample Problem

Money, our medium of exchange, must be used not only in business but in personal accounts as well. It is important, therefore, that everyone knows how to use money wisely.

Amortization Payments

Farmers usually have to borrow money for the purchase of a farm. The most successful farmers have followed some well organized plan in the repayment of borrowed money. Amortization payments is one of these plans. Under this system the same amount is paid each year. This pays the interest on the loan and a partial repayment on the principle. In the beginning the larger portion of the payment is interest, and each year the amount for interest decreases and the amount for

principal increases, so that at the end of a given period of years the entire loan is repaid.

A semiannual payment of \$27 retires a \$1000 loan bearing 4 per cent interest in $34\frac{1}{2}$ years.

Example:

How much semiannually will be required to retire a \$10,000 loan at 4 per cent interest in $34\frac{1}{2}$ years?

Solution:

$$\text{Semiannual payment} = \text{Principal} \div 1000 \times \$27$$

$$\text{Semiannual payment} = \$10,000 \div 1000 \times \$27$$

$$\begin{array}{r} 10 \\ 1000 \overline{) 10,000} \\ \underline{10\ 00} \\ 0 \end{array}$$

$$\text{Semiannual payment} = 10 \times \$27$$

$$\text{Semiannual payment} = \$270$$

Calculate the semiannual payments required to retire the following loans bearing interest at 4 per cent in $34\frac{1}{2}$ years:

1. \$22,500
2. \$43,600
3. \$6,000
4. \$5,900
5. \$12,000

BIBLIOGRAPHY

BIBLIOGRAPHY

Books

- CUSHMAN, FRANK. Mathematics and the Machinist's Job. New York: John Wiley and Sons, Inc. 1926. pp. x+226.
- DOOLEY, WILLIAM H. and KRIEGEL, DAVID. New Vocational Mathematics for Boys. New York: D. C. Heath and Company. 1941. pp. v+349.
- FENSKE, T. H., DRAKE, R. M. and EDSON, A. W., General Editor FENN, A. H. Arithmetic in Agriculture. Saint Paul: Webb Book Publishing Company. 1939. pp. x+243.
- FREILICH, AARON, SHONHOLT, HENRY H. and McCORMACK, JOSEPH P. Boston Mathematics - A Correlation and Unification of Intermediate Algebra and Plane Geometry. New York: Silver Burdett and Company. 1934. pp. iii+600.
- HEDSTROM, CARL S. Vocational Mathematics in Unit Form. Ann Arbor, Michigan: Edwards Brothers, Inc. 1935. pp. iii+409.
- JOHNSON, JAMES F. Applied Mathematics. Milwaukee: The Bruce Publishing Company. 1939. pp. v+437.
- LASLEY, SIDNEY J. and MUDD, MYRTLE F. The New Applied Mathematics. New York: Prentice-Hall, Inc. 1937. pp. v+544.
- LENNES, N. J. New Practical Mathematics. New York: The Macmillan Company. 1939. pp. v+426.
- LENNES, N. J. Senior Practical Mathematics. New York: The Macmillan Company. 1941. pp. v+584.
- LEWIS, CURTIS J. Farm Business Arithmetic. New York: D. C. Heath and Company. 1915. pp. xiii+199.
- McGEE, R. V. Mathematics in Agriculture. New York: Prentice-Hall, Inc. 1942. pp. v+189.
- NADLER, MAURICE. Modern Agricultural Mathematics. New York: Orange Judd Publishing Company, Inc. 1942. pp. v+315.
- PALMER, CLAUDE IRWIN. Practical Mathematics - Part I. New York: McGraw-Hill Book Company, Inc. 1918. pp. v+151.
- RALEIGH, SCHORLING and CLARK, JOHN R. Mathematics in Life. Yonkers-on-Hudson, New York: World Book Company. 1937. pp. x+37.
- RUCH, G. M. Living Mathematics. Chicago, Illinois: Scott, Foresman and Company. 1938. pp. 576.

- SHUSTER, CARL N. and BEDFORD, FRED L. Field Work in Mathematics. New York: American Book Company. 1935. pp. iii+168.
- STAR, EDGAR M. and OLDS, EDWIN G. Vocational Mathematics. Philadelphia: P. Blakestin's Son and Company, Inc. 1930. pp. v+184.
- STRATTON, WILLIAM T. and REMICK, B. L. Agricultural Arithmetic. New York: The Macmillan Company. 1916. pp. v+239.
- THOMPSON, C. O. Elements of Practical Mathematics. New York: Prentice-Hall, Inc. 1935. pp. v+382.
- VAN LEUVEN, E. P. General Trade Mathematics. New York: McGraw-Hill Book Company, Inc. 1942. pp. v+575.

Thesis

- CLINE, R. W. Constructing and Evaluating Practice Exercises in Mathematics for Students of Vocational Agriculture in Arizona. Thesis, Ph. D. Columbus, Ohio: The Ohio State University. 1939. pp. 234.

Periodicals

- BANT, JAMES H. "Mathematics in the Integrated Curriculum." The Mathematics Teacher, 27:381-389. December 1934.
- BERTO, EDWIN A. "Mathematics of Aviation." The Mathematics Teacher, 34:305-308. November 1941.
- DOUGLASS, HARL R. "The Double Track Plan of High School Mathematics." The Mathematics Teacher, 36:57-61. February 1943.
- HEDRICK, E. R. "Mathematics and the National Emergency." The Mathematics Teacher, 35:253-259. October 1942.
- HEDSTROM, CARL S. "Mathematics in Vocational Education." Educational Outlook, 7:143-154. March 1933.
- KADUSHIN, J. "Mathematics in Present Day Industry." The Mathematics Teacher, 35:260-264. October 1942.
- KINNEY, L. B. "Reorganization of Mathematics for the National Emergency." The Mathematics Teacher, 36:3-10. January 1943.
- MALLORY, VIRGIL S. "A Course in Mathematics for Pupils Not Going to College." The Mathematics Teacher, 25:340-346. October 1936.
- MANSFIELD, RALPH. "Basic Mathematics." The Mathematics Teacher, 36:235-236. May 1943.

- MEEK, R. R. and ZECHIEL, A. N. "Functional Mathematics Teaching." Educational Research Bulletin, 19:479-482. November 20, 1940.
- "Number Please." Scholastic, 41:39. September 21, 1942. (An editorial.)
- REEVE, WILLIAM D. "A Proposal for Mathematics Education in the Secondary Schools of the United States." The Mathematics Teacher, 36:11-20. January 1943.
- RICHTMEYER, C. C. "A Course in Applied Mathematics for Teachers of Secondary Mathematics." The Mathematics Teacher, 31:51-62. February 1938.
- SCHAAF, WILLIAM L. "The Dilemma of Vocational Mathematics." School Science and Mathematics, 42:542-549. June 1942.
- SMITH, PAUL C. "The Navy and the Schools." The Mathematics Teacher, 35:248-249. October 1942.
- STARR, D. W. "Enrichment Materials for First-Year Algebra." The Mathematics Teacher, 32:68-77. February 1939.
- WASHBURNE, C. W. "Functional Arithmetic." Educational Method, 16:167-170. January 1937.
- WILLEY, ROY DEVERL. "Functional Arithmetic." The Journal of Educational Psychology, 33:105-117. February 1942.
- WITTICH, WALTER A. "School and Community Look at the Content of Consumer Mathematics." The Mathematics Teacher, 36:106-108. March 1943.

APPENDIX

APPENDIX A

Form Letter Sent to County Supervisors

Millersburg High School
Millersburg, Pa.
July 11, 1944

To complete the work on my thesis, "Functional Mathematics for Students of Vocational Agriculture", I would like to contact those teachers of vocational agriculture who teach agricultural mathematics to the students in their departments.

Mr. V. A. Martin suggested that you area supervisors might be able to give me the list of men in your particular areas who offer a course of this type.

If you find it convenient, will you please list the names of such teachers in the space provided below and return to me in the enclosed envelope.

Sincerely yours,

Oscar A. Kimmel
Teacher of Vocational Agriculture

Name:

Address:

1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____
7. _____	_____

APPENDIX B

Questionnaire Sent to Teachers of Vocational Agriculture

SURVEY OF MATHEMATICS INSTRUCTION
RECEIVED BY
STUDENTS OF VOCATIONAL AGRICULTURE
IN PENNSYLVANIA

Name _____ School _____
Town _____ County _____ Date _____

- I. How many students of vocational agriculture are you teaching this year? Indicate by grades.
9th _____ 10th _____ 11th _____ 12th _____
Total _____
- II. Record the number of students of vocational agriculture enrolled in your school this year in each of the following mathematics courses.
- a. General mathematics _____
 - b. Algebra I _____
 - c. Algebra II _____
 - d. Plane geometry _____
 - e. Solid geometry _____
 - f. Trigonometry _____
 - g. Mathematics for students
of vocational agriculture _____
- III. Underscore the word or words which most nearly express the value of each of the following subjects to students of vocational agriculture after they have become established in farming.
- a. General mathematics (very valuable, valuable, of no value)
 - b. Algebra I (very valuable, valuable, of no value)
 - c. Algebra II (very valuable, valuable, of no value)
 - d. Plane geometry (very valuable, valuable, of no value)
 - e. Solid geometry (very valuable, valuable, of no value)
 - f. Trigonometry (very valuable, valuable, of no value)
 - g. Mathematics for students of vocational agriculture
(very valuable, valuable, of no value)
- IV. Does the teacher of mathematics utilize the practical applications of mathematics to agriculture as a part of his course? Underscore one (yes, no)
- V. Do you include definite, organized instruction in mathematics as a part of your regular course in vocational agriculture? Underscore one (yes, no)

VI. Check any of the following which you feel should be included in a course of study of vocational agriculture.

Dairy

1. () Figuring production records.
2. () Standardizing milk and cream.
3. () Computing butterfat in milk and cream.
4. () Calculating herd production averages.
5. () Using ration tables for feeding dairy cows.
6. () Evaluating feeds to be purchased.
7. () Keeping feeding records.
8. () Calculating the annual amount of roughage which will be needed on the dairy farm.
9. () Calculating the size of barn required.
10. () Figuring gestation periods.

List others:

Livestock

1. () Calculating rations.
2. () Determining the quantities of feed needed.
3. () Estimating shrinkage in shipping.
4. () Determining dressing percentage.
5. () Analyzing the value of margin in feeding livestock.
6. () Using the corn-hog ratio.

List others:

Poultry

1. () Calculating the number of birds that may be placed in a building.
2. () Determining feeding space required for a flock of birds.
3. () Estimating roosting space for a pen of birds.
4. () Figuring number of nests required for a pen of birds.
5. () Calculating number of lighting units required per pen for artificial illumination.
6. () Determining percentage of production.
7. () Calculating average number of eggs per bird.
8. () Determining the cost of producing a dozen of eggs.
9. () Figuring the cost of rearing a pullet.
10. () Calculating the percentage of hatchability.

List others:

Crops, Soils and Fertilizers

1. () Determining the cost of production per acre or other unit of production.
2. () Comparing cost of plant food in fertilizers of different analysis.
3. () Using farm level in laying tile and laying out contour lines.
4. () Estimating amount of grain in a bin, hay or straw in a mow, silage in a silo.
5. () Calculating corn acreage required to fill a silo.
6. () Determining the amount of seed required to plant a given acreage.

Crops, Soils and Fertilizers (continued)

7. () Calculating the amount of fertilizer required for a given acreage.
8. () Determining the percentage of germination.
9. () Using proportion in mixing sprays.
10. () Learning the meaning of fertilizer formulas.

List others:

Farm Engineering

1. () Calculating board feet.
2. () Figuring bill of materials.
3. () Measuring rafters.
4. () Estimating the board feet in a standing tree.
5. () Determining the amount of paint to cover a given surface.
6. () Calculating the amount of cement and aggregate required for a given concrete structure.
7. () Reading an electric meter.
8. () Calculating the cost of operating an electric appliance.
9. () Drawing to scale.
10. () Measuring for pipe fitting.

List others:

Farm Economics and Farm Management

1. () Reading and constructing graphs.
2. () Learning to interpret market quotations.
3. () Making a farm inventory.
4. () Keeping farm accounts.
5. () Calculating labor income.

List others:

Financing the Farm Business

1. () Writing a check.
2. () Using promissory notes.
3. () Buying on the installment plan.
4. () Calculating interest.
5. () Saving money.
6. () Buying insurance.
7. () Paying taxes.
8. () Using amortization payments.

List others:

APPENDIX C

Form Letter Which Accompanied the Questionnaire

Millersburg High School

Millersburg, Pa.

The National Emergency has revealed that graduates of our public high schools are not adequately trained in mathematics. This fact led me to conduct a study of the mathematical training received by students enrolled in the vocational departments in Pennsylvania.

The results of this study are to be used to compile a suggested course of study in mathematics for students of vocational agriculture.

If you find it convenient to fill out the accompanying questionnaire and return in the enclosed envelope, it will be of great assistance to me and to the entire vocational agriculture program.

Very truly yours,

Oscar A. Kimmel

Teacher of Vocational Agriculture

**End of
Title**